

Chapter 269

Randomization Lists

Introduction

This module is used to create a randomization list for assigning subjects to one of up to 25 treatment groups. The list can be stratified by up to 25 centers (strata) with an additional 2 stratification factors, each with up to 25 levels.

Seven randomization algorithms are available. Five of the algorithms (Block Randomization, Efron's biased coin randomization, Smith's randomization, Wei's urn randomization, and random sorting using maximum allowable % deviation) are designed to generate balanced random samples throughout the course of an experiment. The other two (complete randomization and random sorting) are less complex but have higher probabilities of imbalance. Technical details for each of these algorithms (except random sorting) as well as a discussion of randomization issues in general are given in Rosenberger and Lachin (2002), Pocock (1983), and Piantadosi (2005).

Why Randomize?

Random allocation has been an important part of scientific discovery since the time of R.A. Fisher. He and other scientists recognized the potential for bias in nonrandomized experiments that could compromise treatment comparisons. Randomization controls the influence of unknown factors, reducing potential bias in an experiment. Rosenberger and Lachin (2002) state on page 18 that "...the randomization of subjects between the treatment groups is the paramount statistical element that allows one to claim that a study is unbiased." The elimination of bias, however, is not the only reason for randomization. Pocock (1983) states on page 50 that randomization is used "to provide a basis for the standard methods of statistical analysis such as significance tests." Clearly, randomization is necessary in order to produce accurate and generalizable statistical conclusions.

Randomization in Clinical Trials

In non-clinical (or non-human) experiments, researchers often have tight control over the environment and conditions surrounding an experiment, so randomization can usually be implemented with minor difficulty. Clinical experiments, however, are quite different. Because human patients are used in clinical trials, various ethical issues must be addressed. These ethical considerations complicate the experimental design and often require adjustments in the way subjects are randomly assigned to treatments. Other factors that influence randomization in clinical trials are purely logistical. How can the investigators ensure that treatments are administered the same for all patients without the patient or the doctor knowing what treatment is being given? These and other design factors influence how randomization is administered in clinical trials.

One of the issues that arise in clinical experiments is treatment imbalance. Clinical trials are usually administered over time with patients enrolling at different time points throughout the study. It is often desirable to maintain balance in the number of patients assigned to each treatment throughout the course of the experiment. This is particularly true when time-dependent covariates influence the response or when sequential testing will be used to analyze results. Several randomization algorithms have been developed to produce lists that balance the number of patients assigned to each treatment throughout the experiment while still maintaining the randomness of the assignments. These include block randomization, Efron's biased coin randomization, Smith's randomization,

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Wei’s urn randomization, and random sorting using maximum allowable % deviation. Each of these algorithms will be discussed in detail in the section that follows.

Randomization Algorithms

Seven different randomization algorithms are available. These can be roughly divided into two categories: those that aim to produce balanced randomization lists and those that do not. The following table outlines the goal of each algorithm by the number of groups each algorithm will allow.

	Non-Balancing Algorithms	Balancing Algorithms
2 Groups	Complete Randomization [†] , Random Sorting	Block Randomization [†] , Efron’s Biased Coin ^{*†} , Smith ^{*†} , Wei’s Urn ^{*†} , Random Sorting using Maximum Allowable % Deviation
k Groups	Complete Randomization [†] , Random Sorting	Block Randomization [†] , Wei’s Urn [*] , Random Sorting using Maximum Allowable % Deviation

*These randomization algorithms have the additional restriction that unequal treatment allocation is not allowed, i.e. all groups must have the same target sample size.

†These randomization algorithms produce randomization lists in which the actual group sample size may not equal the target group sample size.

The discussion of each algorithm that follows will be based on the following scenario and notation. Suppose we have k treatments and that n_i subjects (not necessarily all equal) are to be assigned to each treatment, $i = 1, 2, \dots, k$. The value n_i will be referred to in discussion as the “target” sample size for each group. Let the actual sample size for each group be a_i . For some algorithms, the actual group sample size may not always equal the target sample size for all groups. The total sample size is

$$N = \sum_{i=1}^k n_i = \sum_{i=1}^k a_i ,$$

and the target allocation ratio for each group is

$$R_i = \frac{n_i}{N} .$$

Define the probability of assignment of subject j to treatment i as p_{ij} .

Define the number of subjects in each group after the j^{th} subject is assigned as $n_i[j]$.

When the list is stratified with centers and/or additional stratification factors, randomization is completed independently within each strata combination. This is, for $s = 1, 2, \dots, S$ strata, the total sample size (N in the notation above) within a given stratum is equal to N_s . The individual strata may have different sample sizes. All discussions that follow refer to randomization within a single stratum, but the results can be generalized to stratified randomization lists.

Non-Balancing Algorithms

Complete Randomization

The complete randomization algorithm is commonly referred to as a “coin flip”. For the case to two treatments, a coin is flipped each time a subject is to be randomized, determining the assignment. The probability of assignment to either treatment is 0.5 for all subjects.

The algorithm generalizes to more than two groups and allows for unequal allocation. The probability of assignment of subject j to group i is

$$p_{ij} = R_i$$

for all j . If the target sample size is the same for all k groups, then

$$p_{ij} = 1/k$$

The complete randomization algorithm proceeds by randomly assigning subjects to treatments using the above assignment probabilities. The algorithm may result in imbalances between groups even when the target group sample sizes are equal, i.e. the actual sample sizes may not always equal the target sample sizes for all groups. This algorithm is not recommended when balance is important throughout the course of an experiment.

Random Sorting

The random sorting algorithm can be used for any number of treatment groups and any allocation ratios. The random sorting algorithm always results in randomized assignment lists in which the actual group sample sizes match the target group sample sizes, i.e. $a_i = n_i$ for all i . The algorithm begins by creating a virtual database containing group names. Each row corresponds to one group, and the i^{th} group is represented by n_i rows. For example, if we were randomly assigning three groups (A, B, and C) with ten subjects in each group, then the database would consist of ten rows containing A's, followed by ten rows containing B's and ten rows containing C's, for a total of 30 rows. Next, a random number is assigned to each row in the database, and then the database is sorted based on the column of random numbers to place the group names in random order. The first subject is then assigned to the group in row one of the randomly sorted database, the second subject is assigned to the group in row two, and so forth. Although this algorithm always results in groups containing the target sample sizes, longitudinal imbalances among groups may still occur, therefore, this algorithm is not recommended when balance is important throughout the course of an experiment.

Balancing Algorithms

Block Randomization

This algorithm is designed to randomize subjects to two or more treatments and achieves balance across treatment groups over time. Predetermined blocks of set sizes containing each treatment assignment are individually randomized to keep the number of subjects assigned to each group in balance as enrollment progresses.

Block randomization is completed as follows:

For randomization of k groups, define r_i as an integer allocation ratio value for group i . For a study with 3 treatments with equal sample sizes in each group (i.e. allocation ratio = 1:1:1), $r_i = 1$ for all k . If the allocation ratio were 1:2:2, then $r_1 = 1$, $r_2 = 2$, and $r_3 = 2$. The minimum block size is equal to

$$B_{Min} = \sum_{i=1}^k r_i.$$

Thus, for a study with 3 groups, $B_{Min} = 3$ for the case of equal group sizes, and $B_{Min} = 5$ for 1:2:2 allocation.

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The actual block sizes used in randomization are computed as multiples of B_{Min} , using block size multipliers, M_b ($b = 1, 2, \dots$ # of block sizes) entered by the user

$$B_b = M_b \times B_{Min}$$

If multipliers $M_b = 1, 2,$ and 3 were used, then for equal allocation the block sizes would be $3, 6,$ and $9,$ with treatments allocated within each block according to the given ratio. For $1:2:2$ allocation, the block sizes would be $5, 10,$ and $15.$ In general, the multipliers should be chosen so that the block sizes are relatively small to maintain balance, and at least two different block sizes should be selected to avoid the possibility of administrators or subjects being able to guess their treatment in a blinded study by the assignment of previous subjects. When multiple block sizes are randomly assigned, the current treatment cannot usually be guessed based solely on the previous assignments, because the block sizes are not constant.

After the block sizes have been determined, all possible permuted combinations of assignment sequences within each block must be calculated. For 3 groups (A, B, C) and a block size of 3, the possible block sequences are

$$ABC, ACB, BAC, BCA, CAB, CBA$$

Block sizes and sequences are chosen and randomly ordered to determine subject assignment into the treatment groups. The user can specify whether the block sizes are chosen completely at random or according to a custom block-subject allocation. The random block selection terminates when the number of subjects assigned in blocks reaches or surpasses the required sample size. It is possible for the final sample size to be larger than the target unless the block sizes are constrained to a set where the overall target sample size is achieved.

Efron's Biased Coin Randomization

This algorithm may only be used for random assignment of subjects to two treatments. The target sample sizes must also be the same for both groups. In order to achieve longitudinal balance between groups, the algorithm dynamically changes the group assignment probabilities. The algorithm is outlined in Efron (1971).

First we define a constant probability p (called "Efron's p "), where $0.5 < p \leq 1.$ A common value for p is $2/3.$ Also define a difference function $D_j = n_1[j] - n_2[j].$ The probability of assignment of subject j to group 1 is

$$p_{1j} = \begin{cases} 1/2 & \text{if } D_{j-1} = 0 \\ p & \text{if } D_{j-1} < 0 \\ 1-p & \text{if } D_{j-1} > 0 \end{cases}$$

Efron's biased coin randomization proceeds by randomly assigning subjects to treatments using the above assignment probabilities. When group 1 has more subjects assigned than group 2, the assignment probability changes to make group 2 more probable for assignment. When group 2 has more, then group 1 becomes more probable. The algorithm may result in final imbalances between groups, but the degree of imbalance throughout the randomization process is greatly reduced.

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Smith's Randomization

This algorithm may only be used for random assignment of subjects to two treatments. The target sample sizes must also be the same for both groups. Like Efron's biased coin randomization, Smith's algorithm dynamically changes the group assignment probabilities based on the degree of imbalance to achieve longitudinal balance between groups. The algorithm is outlined in Smith (1984).

We define a positive exponent parameter ρ (called "Smith's Exponent"). The probability of assignment of subject j to group 1 is

$$p_{1j} = \frac{n_2[j-1]^\rho}{n_1[j-1]^\rho + n_2[j-1]^\rho}$$

Smith's randomization proceeds by randomly assigning subjects to treatments using the above assignment probabilities. When group 1 has more subjects assigned than group 2, the assignment probability changes to make group 2 more probable for assignment. When group 2 has more, then group 1 becomes more probable. The algorithm may result in final imbalances between groups, but the degree of imbalance throughout the randomization process is greatly reduced.

Wei's Urn Randomization

This algorithm may be used for random assignment of subjects to two or more treatments. The target sample sizes must also be the same for all groups. Like Smith's randomization, Wei's urn randomization algorithm dynamically changes the group assignment probabilities based on the degree of imbalance to achieve longitudinal balance between groups. Urn randomization is reviewed in Wei and Lachin (1988).

Define positive parameters A and B (called "Wei's A " and "Wei's B ", respectively). We start the algorithm by placing A balls representing each group in an urn. A single ball is then randomly chosen from the urn, recorded, and *replaced*, and then B new balls corresponding to each of the other groups are added to the urn. Therefore, when a ball from one group is chosen, the probability shifts to make the other groups more probable on the next draw. The probability of the first assignment is $1/k$. After that, the probability of assignment of subject j to group i is

$$p_{ij} = \frac{A + B(j-1) - Bn_i[j-1]}{kA + B(j-1)(k-1)}.$$

The algorithm continues until all subjects have been assigned to one of the groups. The algorithm may result in final imbalances between groups, but the degree of imbalance throughout the randomization process is diminished due to the shifting of probabilities toward the underrepresented groups.

Random Sorting using Maximum Allowable % Deviation

This algorithm is equivalent to the random sorting algorithm described earlier except that a search is conducted to find a randomization list that satisfies the Maximum Allowable % Deviation criterion. The % Deviation for group i after subject j has been assigned is defined as

$$\begin{aligned} \% \text{ Deviation}_{ij} &= \left| \frac{n_i[j] - E(n_i[j])}{n_i} \right| \times 100 \\ &= \left| \frac{n_i[j] - jR_i}{n_i} \right| \times 100. \end{aligned}$$

The % Deviation measures how far the actual sample size for group i is from the expected sample size after subject j is randomly assigned. The Maximum Allowable % Deviation represents the upper bound for this measure. The search is conducted by creating an assignment list based on random sorting and then running through the assignments and calculating the maximum % Deviation for all groups after each assignment. If the maximum % Deviation is greater than the Maximum Allowable % Deviation value specified, then the list is

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rejected, the number of iterations is incremented, and the random sorting algorithm is started again with a new set of random numbers. The search continues until a randomization list is generated for which the criterion is satisfied for all individual assignments. Conducting a search in this manner assures a degree of balance throughout the course of the experiment.

For example, for 40 subjects to be assigned to two groups A and B with equal allocation ratios (0.5), suppose that there are 7 assigned A's and 3 assigned B's after 10 random assignments and the Maximum Allowable % Deviation is 10%. With the allocation ratio at 0.5, we would expect to have 5 A's and 5 B's ($10 \times 0.5 = 5$) after 10 assignments. Therefore, the % Deviation for group A is $|7 - 5|/20 = 10\%$ and the % Deviation for group B is $|3 - 5|/20 = 10\%$. Both of these are equal to the Maximum Allowable % Deviation so the next assignment would be tested. If the next assignment were to group A then the randomization list would be rejected because the % Deviation for group A is $|8 - 5|/20 = 15\% > 10\%$. A new randomization list based on random sorting would be generated and the search would continue.

Comparison of Balancing Properties

Rosenberger and Lachin (2002) provides a simulation comparison of the balancing properties of complete randomization, Efron's biased coin ($p = 2/3$), Wei's Urn ($A = 0, B = 1$), and Smith (exponent = 5). The simulation was carried out for two treatment groups with target sample sizes of 25 in each group. They found that complete randomization did not balance as well as the other three "restricted randomization" procedures. Efron's biased coin and Smith's randomization algorithms were very close in terms of bias and variability. Wei's urn was found to be slightly more variable.

Example 1 – Block Randomization with Equal Allocation Ratios

A clinical researcher wishes to randomly assign 60 subjects to three treatment groups (Low, Medium, High) using block randomization with 1:1:1 allocation and block sizes of 3 and 6. The list will include sequence numbers, subject ID's, block identifiers, abbreviated treatment codes, and randomization codes.

For reproducibility, we will use a random seed of 60502.

Setup

To run this example, complete the following steps:

1 Specify the Randomization Lists procedure options

- Find and open the **Randomization Lists** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 1** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Randomization Tab	
Randomization Algorithm	Block Randomization
Random Seed.....	60502 (for reproducibility)
Block Size Multiplier(s)	1 2
Block-Subject Allocation	Random
Constrain the actual block allocation... ..	Unchecked
Search for a randomization list... ..	Unchecked
Maximum Search Iterations.....	1000
Sample Size Entry Type.....	Enter the Overall Total Sample Size for the Study
Overall Total Sample Size	60
Number of Treatment Groups.....	3
Title or Name	Treatment
Assign Equal Sample Sizes to All Treatment Groups	Checked
Treatment Group 1 Label	Low
Treatment Group 2 Label	Medium
Treatment Group 3 Label	High
Centers (Strata) Tab	
Number of Centers (Strata)	1 (Not Stratified)
Number of Additional Factors	0
List Options Tab	
Include a Column of Sequence Numbers.....	Checked
Include a Column of Subject ID's	Checked
Subject ID Prefix	{Set}
Include a Column of Block Identifiers	Checked
Include a Column of Combined Stratification Codes.....	Unchecked
Include a Column of Abbreviated Treatment Codes	Checked
Include a Column of Unique Randomization Codes.....	Checked

Randomization Lists

Reports Tab

- Show Summary **Checked**
- Show Randomization List **Checked**
- Show Randomization List Details **Checked**
- Show References **Checked**

Storage Tab

- Write Randomization List to Spreadsheet **Unchecked**

2 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Annotated Output

Randomization List Summary

Randomization List Summary					
Randomization Algorithm	Block Randomization				
User-Entered Random Seed	60502				
Block Size Multiplier(s)	1 2				
Block Size(s)	3 6				
Total Number of Blocks	12				
Overall Total Sample Size	60				
Number of Treatment Groups	3				
Treatment	Treatment Code	Sample Size	— Allocation % —		
			Actual	Target	
Low	L	20	33.33%	33.33%	
Medium	M	20	33.33%	33.33%	
High	H	20	33.33%	33.33%	

This report displays the summary of the randomization list, including block information.

Randomization Algorithm

States the algorithm used in randomization and any associated parameters (e.g. Block Size Multiplier(s), Block Size(s), Total Number of Blocks).

Random Seed

Indicates the random seed used in creating the randomization list. If the random seed was computer-generated, it will be indicated here.

Overall Total Sample Size

The actual sample size of the randomization list. If the sample size is different from the target, the target sample size will be indicated here.

Number of Treatment Groups

The treatment groups.

Treatment

The treatment groups.

Treatment Code

The abbreviated treatment group code.

Sample Size

The sample size for each treatment group.

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Actual Allocation %

The actual allocation percentage achieved by each treatment group.

Target Allocation %

The target allocation percentage specified on the input. Note that the user input may have had integer values for the allocation ratios (e.g. 1:1:1), but they are converted to percentages in this report.

Randomization List

Randomization List					
Randomization Algorithm		Block Randomization (Block Sizes = 3 6)			
User-Entered Random Seed		60502			
Sequence	Subject ID	Block	Treatment	Treatment Code	Randomization Code
1	101	1	High	H	MW0
2	102	1	Low	L	RN7
3	103	1	Low	L	GI8
4	104	1	Medium	M	DX0
5	105	1	Medium	M	TD6
6	106	1	High	H	RN2
7	107	2	Low	L	LF5
8	108	2	Low	L	QD8
9	109	2	High	H	CZ9
10	110	2	High	H	PL6
11	111	2	Medium	M	QA4
12	112	2	Medium	M	RY0
13	113	3	Low	L	UI2
14	114	3	Low	L	BH6
15	115	3	Medium	M	BF3
.
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.
46	146	9	Low	L	EG9
47	147	9	High	H	OJ4
48	148	9	Low	L	CB0
49	149	10	Low	L	GX3
50	150	10	High	H	IK6
51	151	10	Medium	M	XO1
52	152	11	Medium	M	FB6
53	153	11	High	H	ZP2
54	154	11	Low	L	XW6
55	155	12	Low	L	VA3
56	156	12	High	H	XE5
57	157	12	Low	L	LD8
58	158	12	Medium	M	BV4
59	159	12	Medium	M	FW2
60	160	12	High	H	XI6

This report shows the complete randomization list

Sequence

The sequence identifier.

Subject ID

The text identification value of the subject.

Block

The randomization block to which each subject belongs.

Treatment

The treatment group to which the subject was randomly assigned.

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Treatment Code

An abbreviated treatment code corresponding to the treatment group.

Randomization Code

Unique, random, computer-generated code for each subject. This information can be used to blind the study.

Randomization List Details

Randomization List Details					
Randomization Algorithm		Block Randomization (Block Sizes = 3 6)			
Number of Blocks		12			
Sample Size		60			
Number of Treatment Groups		3			
Block-Subject Allocation					
Block Size	Number of Blocks	Subjects Assigned	— Allocation % —		
			Actual	Target	
3	4	12	20%	Random	
6	8	48	80%	Random	

This report displays a more detailed summary of the randomization list, including block information in the Block-Subject Allocation section.

Block Size

The block sizes used to create the randomization list.

Number of Blocks

The number of blocks of each size.

Subjects Assigned

The number of subjects assigned to the list by blocks of the corresponding size.

Actual Allocation %

The actual allocation percentage achieved by each block size.

Target Allocation %

The target allocation percentage specified on the input. Note that the user input may have had integer values for the allocation ratios (e.g. 1:1:1), but they are converted to percentages in this report.

Treatment Groups				
Treatment	Treatment Code	Sample Size	— Allocation % —	
			Actual	Target
Low	L	20	33.33%	33.33%
Medium	M	20	33.33%	33.33%
High	H	20	33.33%	33.33%

This section displays the same sample size information as is found in the Randomization List Summary report.

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Cumulative Details					
Sequence	Subject ID	Block	Treatment	Largest % Deviation from Target	Cumulative Sample Size (L, M, H)
1	101	1	High	3.33%	(0, 0, 1)
2	102	1	Low	3.33%	(1, 0, 1)
3	103	1	Low	5.00%	(2, 0, 1)
4	104	1	Medium	3.33%	(2, 1, 1)
5	105	1	Medium	3.33%	(2, 2, 1)
6	106	1	High	0.00%	(2, 2, 2)
7	107	2	Low	3.33%	(3, 2, 2)
8	108	2	Low	6.67%	(4, 2, 2)
9	109	2	High	5.00%	(4, 2, 3)
10	110	2	High	6.67%	(4, 2, 4)
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.
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49	149	10	Low	3.33%	(17, 16, 16)
50	150	10	High	3.33%	(17, 16, 17)
51	151	10	Medium	0.00%	(17, 17, 17)
52	152	11	Medium	3.33%	(17, 18, 17)
53	153	11	High	3.33%	(17, 18, 18)
54	154	11	Low	0.00%	(18, 18, 18)
55	155	12	Low	3.33%	(19, 18, 18)
56	156	12	High	3.33%	(19, 18, 19)
57	157	12	Low	5.00%	(20, 18, 19)
58	158	12	Medium	3.33%	(20, 19, 19)
59	159	12	Medium	3.33%	(20, 20, 19)
60	160	12	High	0.00%	(20, 20, 20)

This report shows more detailed summaries and cumulative randomization list details.

Sequence

The sequence identifier.

Subject ID

The text identification value of the subject.

Block

The randomization block to which each subject belongs.

Treatment

The treatment group to which the subject was randomly assigned.

Largest % Deviation from Target

The largest observed % deviation after the current assignment was made. This measures how far away the group sample sizes are from the expected sample size based on the targets. That is, this measures the degree of imbalance over time.

Cumulative Sample Size

The cumulative sample size total for each treatment group after the current assignment was made.

References

References

- Piantadosi, S. 2005. *Clinical Trials - A Methodological Perspective*. John Wiley & Sons. New Jersey.
- Pocock, S.J. 1983. *Clinical Trials - A Practical Approach*. John Wiley & Sons. New York.
- Rosenberger, W.F., and Lachin, J.M. 2002. *Randomization in Clinical Trials - Theory and Practice*. John Wiley & Sons. New York.

This report displays the references associated with this procedure.

Example 2 – Block Randomization with Unequal Allocation Ratios and Centers

Continuing with Example 1, suppose the researcher wants now to create a randomization list with twice as many Low treatments as the other two (allocation = 2:1:1) at 4 different centers. Each center should have 80 subjects. They want to randomize with block sizes of 4, 8, and 12 with an equal number of subjects randomized by each block size. We'll also save the randomization list to the Data Table.

For reproducibility, we will use a random seed of 102203.

Setup

To run this example, complete the following steps:

1 Specify the Randomization Lists procedure options

- Find and open the **Randomization Lists** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 2** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Randomization Tab	
Randomization Algorithm	Block Randomization
Random Seed.....	102203 (for reproducibility)
Block Size Multiplier(s)	1 2 3
Block-Subject Allocation	Equal
Constrain the actual block allocation... ..	Unchecked
Search for a randomization list... ..	Unchecked
Maximum Search Iterations.....	1000
Sample Size Entry Type	Enter Individual Center (Stratum) Sample Sizes
Number of Treatment Groups.....	3
Title or Name	Treatment
Assign Equal Sample Sizes to All Treatment Groups	Unchecked
Treatment Group 1 Label	Low
Treatment Group 1 Allocation Ratio	2
Treatment Group 2 Label	Medium
Treatment Group 2 Allocation Ratio	1
Treatment Group 3 Label	High
Treatment Group 3 Allocation Ratio	1
Centers (Strata) Tab	
Number of Centers (Strata)	4
Title or Name	Center
Assign Equal Sample Sizes to All Centers (Strata).....	Checked
Center Sample Size.....	80
Center (Stratum) 1 Label	Center 1
Center (Stratum) 2 Label	Center 2
Center (Stratum) 3 Label	Center 3
Center (Stratum) 4 Label	Center 4
Number of Additional Factors	0

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List Options Tab

- Include a Column of Sequence Numbers.....**Checked**
- Include a Column of Subject ID's**Checked**
 - Restart Numbering for each Center (Stratum)**Checked**
 - Subject ID Prefix**{Set}**
- Include a Column of Block Identifiers**Checked**
- Include a Column of Combined Stratification Codes.....**Unchecked**
- Include a Column of Abbreviated Treatment Codes**Checked**
- Include a Column of Unique Randomization Codes.....**Checked**

Reports Tab

- Show Summary**Checked**
- Show Randomization List.....**Checked**
- Show Randomization List Details.....**Checked**
- Show References**Checked**

Storage Tab

- Store Randomization List**Checked**
- Store Randomization List Data Starting In1
- Update Column Names**Checked**

2 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Output

Randomization List Summary

Randomization List Summary					
Randomization Algorithm	Block Randomization				
User-Entered Random Seed	102203				
Block Size Multiplier(s)	1 2 3				
Block Size(s)	4 8 12				
Total Number of Blocks	52				
Overall Total Sample Size	320				
Number of Treatment Groups	3				
Number of Centers (Strata)	4				
Treatments					
Treatment	Treatment Code	Sample Size	— Allocation % —		
			Actual	Target	
Low	L	160	50%	50%	
Medium	M	80	25%	25%	
High	H	80	25%	25%	
Centers (Strata)					
Center	First Subject ID	Blocks	Sample Size	— Allocation % —	
				Actual	Target
Center 1	1001	13	80	25%	25%
Center 2	2001	13	80	25%	25%
Center 3	3001	13	80	25%	25%
Center 4	4001	13	80	25%	25%

The summary indicates that 80 subjects are randomized within each center. Randomization occurs independently within each Center.

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Randomization List

Randomization List						
Randomization Algorithm		Block Randomization (Block Sizes = 4 8 12)				
User-Entered Random Seed		102203				
Sequence	Subject ID	Center	Block	Treatment	Treatment Code	Randomization Code
1	1001	Center 1	1	Low	L	DNC3
2	1002	Center 1	1	Medium	M	VJF1
3	1003	Center 1	1	High	H	LCD5
4	1004	Center 1	1	Low	L	NBW1
5	1005	Center 1	2	High	H	WVE1
6	1006	Center 1	2	Low	L	LSC6
7	1007	Center 1	2	Medium	M	OWK0
8	1008	Center 1	2	Low	L	UCN3
9	1009	Center 1	3	Low	L	LUS2
10	1010	Center 1	3	Low	L	GFF7
11	1011	Center 1	3	High	H	IZD1
12	1012	Center 1	3	Medium	M	GBL1
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81	2001	Center 2	14	Low	L	MHC0
82	2002	Center 2	14	High	H	OBT8
83	2003	Center 2	14	Low	L	ETC4
84	2004	Center 2	14	Medium	M	FEC7
85	2005	Center 2	15	High	H	FKB5
86	2006	Center 2	15	Low	L	ICL4
87	2007	Center 2	15	Low	L	ZDZ9
88	2008	Center 2	15	High	H	QKM6
89	2009	Center 2	15	Medium	M	CSX4
90	2010	Center 2	15	Medium	M	CNS5
91	2011	Center 2	15	Low	L	EOQ6
92	2012	Center 2	15	Medium	M	RDY5
93	2013	Center 2	15	Low	L	UBO4
94	2014	Center 2	15	Low	L	GAE7
95	2015	Center 2	15	High	H	XIV9
96	2016	Center 2	15	Low	L	CLR4
.
.
.
161	3001	Center 3	27	Low	L	MTA2
162	3002	Center 3	27	High	H	XVZ2
163	3003	Center 3	27	Low	L	IUF0
164	3004	Center 3	27	Medium	M	IFP0
165	3005	Center 3	28	Low	L	YTJ3
166	3006	Center 3	28	Medium	M	MVC7
167	3007	Center 3	28	Low	L	TGE5
168	3008	Center 3	28	High	H	TOP5
.
.
.
241	4001	Center 4	40	Low	L	OJC6
242	4002	Center 4	40	Medium	M	LGS4
243	4003	Center 4	40	Low	L	VID5
244	4004	Center 4	40	High	H	CXU5
.
.
.
317	4077	Center 4	52	Low	L	FYT2
318	4078	Center 4	52	Low	L	TXK8
319	4079	Center 4	52	High	H	YPT8
320	4080	Center 4	52	Medium	M	FJA0

The randomization list has a length of 320 subjects with 80 each in 4 different centers. This randomization list will also have been written to the Data Table.

Randomization Lists

Randomization List Details

Randomization List Details for Strata Combination 1 of 4					
Strata Combination	Center = "Center 1"				
Randomization Algorithm	Block Randomization (Block Sizes = 4 8 12)				
Number of Blocks	13				
Sample Size	80				
Number of Treatment Groups	3				
Block-Subject Allocation					
Block Size	Number of Blocks	Subjects Assigned	— Allocation % —		
			Actual	Target	
4	8	32	40%	33.33%	
8	3	24	30%	33.33%	
12	2	24	30%	33.33%	
Treatment Groups					
Treatment	Treatment Code	Sample Size	— Allocation % —		
			Actual	Target	
Low	L	40	50%	50%	
Medium	M	20	25%	25%	
High	H	20	25%	25%	
Cumulative Details					
Sequence	Subject ID	Block	Treatment	Largest % Deviation from Target	Cumulative Sample Size (L, M, H)
1	1001	1	Low	1.25%	(1, 0, 0)
2	1002	1	Medium	2.50%	(1, 1, 0)
3	1003	1	High	1.25%	(1, 1, 1)
4	1004	1	Low	0.00%	(2, 1, 1)
5	1005	2	High	3.75%	(2, 1, 2)
6	1006	2	Low	2.50%	(3, 1, 2)
7	1007	2	Medium	1.25%	(3, 2, 2)
8	1008	2	Low	0.00%	(4, 2, 2)
9	1009	3	Low	1.25%	(5, 2, 2)
10	1010	3	Low	2.50%	(6, 2, 2)
.
.
.

(Output continues with a separate Randomization List Details report for each center.)

The Randomization List Details report indicates that while it was intended to have an equal number of subjects assigned to each block size, the actual percentages were just a little off due to the discrete nature of the block sizes and total sample size.

Example 3 – Block Randomization within Centers with Two Additional Stratification Factors

Suppose a study is to be conducted at 3 centers with randomization using 2 stratification factors: Gender (Male, Female) and Size (Small, Medium, Large). The treatment allocation will be equal among 3 groups (A, B, C) and randomized by block randomization with custom block-subject allocation such that 40% of subjects are randomized using a block size of 3 and 60% are randomized using a block size of 6. The actual block allocation will be constrained so that the total sample size matches the target if possible. We'll create a randomization list with 1000 subjects and save it to the Data Table.

Center 1 is expected to have half as many subjects as the other two. It is also expected that there will be a ratio of males to females of 3:2 and an equal allocation of subjects among the three sizes.

For reproducibility, we will use a random seed of 90605.6497.

Setup

To run this example, complete the following steps:

1 Specify the Randomization Lists procedure options

- Find and open the **Randomization Lists** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 3** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Randomization Tab	
Randomization Algorithm	Block Randomization
Random Seed.....	90605.6497 (for reproducibility)
Block Size Multiplier(s)	1 2
Block-Subject Allocation	Custom
Custom Block-Subject Allocation.....	40 60
Constrain the actual block allocation... ..	Checked
Search for a randomization list... ..	Unchecked
Maximum Search Iterations.....	1000
Sample Size Entry Type	Enter the Overall Total Sample Size for the Study
Overall Total Sample Size	1000
Number of Treatment Groups.....	3
Title or Name	Group
Assign Equal Sample Sizes to All Treatment Groups	Checked
Treatment Group 1 Label	A
Treatment Group 2 Label	B
Treatment Group 3 Label	C
Centers (Strata) Tab	
Number of Centers (Strata)	3
Title or Name	Center
Assign Equal Sample Sizes to All Centers (Strata).....	Unchecked
Center (Stratum) 1 Label	Center 1
Center (Stratum) 1 Allocation Ratio.....	0.5
Center (Stratum) 2 Label	Center 2
Center (Stratum) 2 Allocation Ratio.....	1

Randomization Lists

Center (Stratum) 3 Label	Center 3
Center (Stratum) 3 Allocation Ratio	1
Number of Additional Factors	2
<i>Stratification Factor 1</i>	
Number of Levels	2
Title or Name	Gender
Use Equal Sample Size Allocation for All Levels	Unchecked
Level 1 Label	Male
Level 1 Allocation Ratio	3
Level 2 Label	Female
Level 2 Allocation Ratio	2
<i>Stratification Factor 2</i>	
Number of Levels	3
Title or Name	Size
Use Equal Sample Size Allocation for All Levels	Checked
Level 1 Label	Small
Level 2 Label	Medium
Level 3 Label	Large
List Options Tab	
Include a Column of Sequence Numbers	Checked
Include a Column of Subject ID's	Checked
Restart Numbering for each Center (Stratum)	Checked
Restart Numbering for each Additional...	Checked
Subject ID Prefix	{Set}000
Include a Column of Block Identifiers	Checked
Include a Column of Combined Stratification Codes	Checked
Use Abbreviated Codes	Checked
Add Code Separators	Unchecked
Include a Column of Abbreviated Treatment Codes	Unchecked
Include a Column of Unique Randomization Codes	Unchecked
Reports Tab	
Show Summary	Checked
Show Randomization List	Checked
Show Randomization List Details	Checked
Show References	Unchecked
Storage Tab	
Store Randomization List	Checked
Store Randomization List Data Starting In	1
Update Column Names	Checked

2 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Randomization Lists

Output

Randomization List Summary

Randomization List Summary									
Randomization Algorithm	Block Randomization								
User-Entered Random Seed	90605.6497								
Block Size Multiplier(s)	1 2								
Block Size(s)	3 6								
Total Number of Blocks	240								
Overall Total Sample Size	1017 (Target was 1000)								
Number of Treatment Groups	3								
Number of Centers (Strata)	3								
Number of Stratification Factor 1 Levels	2								
Number of Stratification Factor 2 Levels	3								
Treatments									
Group	Group Code	Sample Size	— Allocation % —						
			Actual	Target					
A	A	339	33.33%	33.33%					
B	B	339	33.33%	33.33%					
C	C	339	33.33%	33.33%					
Centers (Strata)									
Center	Gender	Size	Stratification Code	First Subject ID	Blocks	Sample Size	— Allocation % —		
							Actual	Target	
Center 1	Male	Small	1MS	10000001	10	42	4.13%	4.00%	
Center 1	Male	Medium	1MM	20000001	10	42	4.13%	4.00%	
Center 1	Male	Large	1ML	30000001	10	42	4.13%	4.00%	
Center 1	Female	Small	1FS	40000001	6	27	2.65%	2.67%	
Center 1	Female	Medium	1FM	50000001	6	27	2.65%	2.67%	
Center 1	Female	Large	1FL	60000001	6	27	2.65%	2.67%	
Center 2	Male	Small	2MS	70000001	19	81	7.96%	8.00%	
Center 2	Male	Medium	2MM	80000001	19	81	7.96%	8.00%	
Center 2	Male	Large	2ML	90000001	19	81	7.96%	8.00%	
Center 2	Female	Small	2FS	100000001	13	54	5.31%	5.33%	
Center 2	Female	Medium	2FM	110000001	13	54	5.31%	5.33%	
Center 2	Female	Large	2FL	120000001	13	54	5.31%	5.33%	
Center 3	Male	Small	3MS	130000001	19	81	7.96%	8.00%	
Center 3	Male	Medium	3MM	140000001	19	81	7.96%	8.00%	
Center 3	Male	Large	3ML	150000001	19	81	7.96%	8.00%	
Center 3	Female	Small	3FS	160000001	13	54	5.31%	5.33%	
Center 3	Female	Medium	3FM	170000001	13	54	5.31%	5.33%	
Center 3	Female	Large	3FL	180000001	13	54	5.31%	5.33%	

The summary lists the number of subjects randomized by each strata combination. Notice that just about twice as many subjects are assigned in centers 2 and 3 as in center 1. Also note that the ratio of males to females is about 3:2 within each center. The randomization list had to be expanded to 1017 subjects to avoid incomplete blocks.

Randomization Lists

Randomization List

Randomization List							
Randomization Algorithm		Block Randomization (Block Sizes = 3 6)					
User-Entered Random Seed		90605.6497					
Sequence	Subject ID	Center	Gender	Size	Stratification Code	Block	Group
1	10000001	Center 1	Male	Small	1MS	1	A
2	10000002	Center 1	Male	Small	1MS	1	B
3	10000003	Center 1	Male	Small	1MS	1	C
4	10000004	Center 1	Male	Small	1MS	1	A
5	10000005	Center 1	Male	Small	1MS	1	C
6	10000006	Center 1	Male	Small	1MS	1	B
7	10000007	Center 1	Male	Small	1MS	2	B
8	10000008	Center 1	Male	Small	1MS	2	A
9	10000009	Center 1	Male	Small	1MS	2	C
.
.
.
3	20000001	Center 1	Male	Medium	1MM	11	A
44	20000002	Center 1	Male	Medium	1MM	11	C
45	20000003	Center 1	Male	Medium	1MM	11	B
46	20000004	Center 1	Male	Medium	1MM	12	C
47	20000005	Center 1	Male	Medium	1MM	12	A
48	20000006	Center 1	Male	Medium	1MM	12	A
49	20000007	Center 1	Male	Medium	1MM	12	B
50	20000008	Center 1	Male	Medium	1MM	12	B
51	20000009	Center 1	Male	Medium	1MM	12	C
.
.
.
127	40000001	Center 1	Female	Small	1FS	31	C
128	40000002	Center 1	Female	Small	1FS	31	B
129	40000003	Center 1	Female	Small	1FS	31	A
130	40000004	Center 1	Female	Small	1FS	31	B
131	40000005	Center 1	Female	Small	1FS	31	C
132	40000006	Center 1	Female	Small	1FS	31	A
133	40000007	Center 1	Female	Small	1FS	32	C
134	40000008	Center 1	Female	Small	1FS	32	A
135	40000009	Center 1	Female	Small	1FS	32	B
.
.
.
208	70000001	Center 2	Male	Small	2MS	49	C
209	70000002	Center 2	Male	Small	2MS	49	A
210	70000003	Center 2	Male	Small	2MS	49	B
211	70000004	Center 2	Male	Small	2MS	49	C
212	70000005	Center 2	Male	Small	2MS	49	A
213	70000006	Center 2	Male	Small	2MS	49	B
.
.
.
613	130000001	Center 3	Male	Small	3MS	145	C
614	130000002	Center 3	Male	Small	3MS	145	B
615	130000003	Center 3	Male	Small	3MS	145	B
616	130000004	Center 3	Male	Small	3MS	145	A
617	130000005	Center 3	Male	Small	3MS	145	C
618	130000006	Center 3	Male	Small	3MS	145	A
.
.
.
1015	180000052	Center 3	Female	Large	3FL	240	B
1016	180000053	Center 3	Female	Large	3FL	240	A
1017	180000054	Center 3	Female	Large	3FL	240	C

The randomization list has a length of 1017 subjects with 339 in each group. Randomization occurred independently within each strata combination. The randomization list will also have been written to the Data Table.

Randomization Lists

Randomization List Details

Randomization List Details for Strata Combination 1 of 18

Strata Combination Center = "Center 1"
 Gender = "Male"
 Size = "Small"
 Randomization Algorithm Block Randomization (Block Sizes = 3 6)
 Number of Blocks 10
 Sample Size 42
 Number of Treatment Groups 3

Block-Subject Allocation

Block Size	Number of Blocks	Subjects Assigned	Allocation %	
			Actual	Target
3	6	18	42.86%	40%
6	4	24	57.14%	60%

Treatment Groups

Group	Group Code	Sample Size	Allocation %	
			Actual	Target
A	A	14	33.33%	33.33%
B	B	14	33.33%	33.33%
C	C	14	33.33%	33.33%

Cumulative Details

Sequence	Subject ID	Block	Group	Largest % Deviation from Target	Cumulative Sample Size (A, B, C)
1	10000001	1	A	4.76%	(1, 0, 0)
2	10000002	1	B	4.76%	(1, 1, 0)
3	10000003	1	C	0.00%	(1, 1, 1)
4	10000004	1	A	4.76%	(2, 1, 1)
5	10000005	1	C	4.76%	(2, 1, 2)
6	10000006	1	B	0.00%	(2, 2, 2)
7	10000007	2	B	4.76%	(2, 3, 2)
8	10000008	2	A	4.76%	(3, 3, 2)
9	10000009	2	C	0.00%	(3, 3, 3)
10	10000010	3	A	4.76%	(4, 3, 3)
11	10000011	3	C	4.76%	(4, 3, 4)
12	10000012	3	B	0.00%	(4, 4, 4)
13	10000013	4	B	4.76%	(4, 5, 4)
14	10000014	4	A	4.76%	(5, 5, 4)
15	10000015	4	C	0.00%	(5, 5, 5)
.
.
.

(Output continues with a separate Randomization List Details report for each strata combination.)

The Randomization List Details reports indicate the allocation within each strata combination. The number of male subjects with Size = Small in Center 1 is 42. Note that the number of subjects randomized using each block size matches closely our specified percentages of 40% and 60%.

Example 4 – Complete Randomization and Imbalance

In this example we'll demonstrate the imbalance that can occur when using complete randomization by generating a simple randomization list with 20 subjects and 2 treatment groups, A and B.

For reproducibility, we will use a random seed of 60608.

Setup

To run this example, complete the following steps:

1 Specify the Randomization Lists procedure options

- Find and open the **Randomization Lists** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 4a** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Randomization Tab	
Randomization Algorithm	Complete Randomization
Random Seed.....	60608 (for reproducibility)
Search for a randomization list... ..	Unchecked
Maximum Search Iterations.....	1000
Sample Size Entry Type	Enter the Overall Total Sample Size for the Study
Overall Total Sample Size	20
Number of Treatment Groups.....	2
Title or Name	Treatment
Assign Equal Sample Sizes to All Treatment Groups	Checked
Treatment Group 1 Label	A
Treatment Group 2 Label	B

2 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Output

Randomization List Summary				
Randomization Algorithm		Complete Randomization		
User-Entered Random Seed		60608		
Overall Total Sample Size		20		
Number of Treatment Groups		2		
	Treatment		— Allocation % —	
Treatment	Code	Sample Size	Actual	Target
A	A	7	35%	50%
B	B	13	65%	50%

Randomization Lists

Randomization List		
Randomization Algorithm	Complete Randomization	
User-Entered Random Seed	60608	
Sequence	Subject ID	Treatment
1	101	B
2	102	A
3	103	B
4	104	A
5	105	B
6	106	B
7	107	B
8	108	A
9	109	B
10	110	A
11	111	B
12	112	B
13	113	A
14	114	B
15	115	B
16	116	B
17	117	B
18	118	B
19	119	A
20	120	A

The randomization list generated using complete randomization has nearly twice as many subjects assigned to group B as A. The actual randomization is imbalanced between groups even though the target was to assign equal sample sizes to both treatment groups.

To search for a balanced randomization list, check **Search for a randomization list...**

3 Search for a randomization list

- The settings for this section are listed below and are stored in the **Example 4b** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Randomization Tab	
Search for a randomization list... ..	Checked

4 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Randomization List Summary				
Randomization Algorithm	Complete Randomization			
User-Entered Random Seed	60608			
Overall Total Sample Size	20			
Number of Treatment Groups	2			
Treatment	Treatment Code	Sample Size	— Allocation % —	
			Actual	Target
A	A	10	50%	50%
B	B	10	50%	50%

Randomization Lists

Randomization List

Randomization Algorithm Complete Randomization
User-Entered Random Seed 60608

Sequence	Subject ID	Treatment
1	101	B
2	102	A
3	103	B
4	104	A
5	105	A
6	106	B
7	107	A
8	108	A
9	109	B
10	110	B
11	111	A
12	112	B
13	113	A
14	114	A
15	115	B
16	116	B
17	117	A
18	118	B
19	119	B
20	120	A

Note: This list was generated by searching for a randomization list in which the final group sizes exactly match the target group sizes. One or more generated lists did not meet the required criteria and were discarded. The number of search iterations to obtain this list was 3.

Example 5 – Assigning Randomly Selected Values to Groups after Simple Random Sampling

Suppose you want to randomly select 15 values from the Resale dataset and assign them to groups with sequential balance. This can be accomplished by first using the Simple Random Sampling procedure to select the values and then using the Block Randomization method in the Randomization Lists procedure to assign the groups.

If you want to randomly assign the selected values to G groups without regard for sequential balance over time, you can accomplish this all in one step using the Simple Random Sampling with Group Assignment procedure.

The purpose of this example is to demonstrate how the Randomization Lists procedure may be used in conjunction with the Simple Random Sampling procedure to assign actual sampled items to groups. The Randomization Lists procedure contains additional randomization algorithms for assigning items to groups that are not available in the Simple Random Sampling with Group Assignment procedure and may be of interest to the user.

For reproducibility, we will use a random seed of 22077 in the Simple Random Sampling procedure and a random seed of 60502 in the Randomization Lists procedure.

Part 1: Simple Random Sampling

Setup

This part of the example will demonstrate how to take a simple random sample from a column in a dataset. We will select 10% of the values in the column called Price. The sample selection data will be stored in collapsed format in the Data Table with row numbers also stored for reference to the original dataset. The resulting sample data will be sorted by value.

To run this part of the example, complete the following steps:

1 Open the Resale example dataset

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Select **Resale** and click **OK**.

2 Specify the Simple Random Sampling procedure options

- Find and open the **Simple Random Sampling** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 2** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Random Sampling Tab	
Sample Size Entry Type	Enter the Percent of Rows/Values to Select
Percent of Rows/Values to Select	10
Dataset Sampling Type	Randomly Select Values from a Column
Column to Sample	Price
Random Seed.....	22077 (for reproducibility)
Reports Tab	
Sort Random Sample List(s)	Checked
Sort Type	By Selected Row/Value

Randomization Lists

Storage Tab

Store the Random Sample(s) in the Data Table **Checked**
 Selection Data to Store..... **Selected Rows/Values (Collapsed)**
 Store the original row number of each selected **Checked**
 value

3 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Random Sampling Summary Report

Simple Random Sampling Summary

Number of Values Selected	15 of 150 (10%)
Dataset Sampling Type	Values Randomly Selected from Price
Number of Random Sample Replicates	1
User-Entered Random Seed*	22077

Storage: The random sample selection data was stored in columns 21 through 22 of the Data Table.

* You can use this random seed to replicate this random sample, but the original dataset, number of random samples to generate, and sampling options must be the same.

This report gives a summary of the random sample that was generated by selecting values from Price. A sample size of 15 corresponds to 10% of all 150 available rows with data. The random sample itself was stored in the Data Table in columns 21 and 22.

Random Sample List Report

Simple Random Sample 1 of 1

Number of Values Selected	15 of 150 (10%)
Dataset Sampling Type	Values Randomly Selected from Price
User-Entered Random Seed	22077

Selected Item	Original Row	Value Selected from Price
1	71	53300
2	20	101800
3	82	122500
4	138	133400
5	64	141400
6	45	151200
7	81	164000
8	119	195400
9	83	202300
10	32	208900
11	74	220600
12	140	233200
13	129	318500
14	105	341000
15	40	357700

This report lists in collapsed format the 15 values from Price (10% of all values) that were selected along with their corresponding original row numbers. The report is sorted by value.

Randomization Lists

Part 1: Stored Random Sample Data

Row	Row 1	Sample 1
1	71	53300
2	20	101800
3	82	122500
4	138	133400
5	64	141400
6	45	151200
7	81	164000
8	119	195400
9	83	202300
10	32	208900
11	74	220600
12	140	233200
13	129	318500
14	105	341000
15	40	357700

In columns 21 and 22 of the Data Table on the Data Window, you’ll find the random sample data stored in collapsed format. The stored data includes the sampled values (“Sample_1”) and the original row numbers (“Row_1”) of the values selected from Price.

The newly created Note for column “Sample_1” contains the following information about the sampled data.

Simple Random Sample Storage Column 1 of 1

Number of Values Selected: 15 of 150 (10%)
 Dataset Sampling Type: Values Randomly Selected from Price
 User-Entered Random Seed*: 22077

* You can use this random seed to replicate this random sample, but the original dataset, number of random samples to generate, and sampling options must be the same.

Part 2: Randomization Lists Procedure

Setup

To run this part of the example, complete the following steps:

4 Specify the Randomization Lists procedure options

- Find and open the **Randomization Lists** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 5** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Randomization Tab	
Randomization Algorithm	Block Randomization
Random Seed.....	60502 (for reproducibility)
Block Size Multiplier(s)	1 2
Block-Subject Allocation	Random
Constrain the actual block allocation... ..	Unchecked
Search for a randomization list... ..	Unchecked
Maximum Search Iterations.....	1000
Sample Size Entry Type.....	Enter the Overall Total Sample Size for the Study

Randomization Lists

Overall Total Sample Size15
 Number of Treatment Groups.....3
 Title or NameGroup
 Assign Equal Sample Sizes to All Treatment GroupsChecked
 Treatment Group 1 LabelA
 Treatment Group 2 LabelB
 Treatment Group 3 LabelC

Centers (Strata) Tab

Number of Centers (Strata)1 (Not Stratified)
 Number of Additional Factors0

List Options Tab

Include a Column of Sequence Numbers.....Checked
 Include a Column of Subject ID'sUnchecked
 Include a Column of Block IdentifiersChecked
 Include a Column of Combined Stratification Codes.....Unchecked
 Include a Column of Abbreviated Treatment CodesUnchecked
 Include a Column of Unique Randomization Codes.....Unchecked

Reports Tab

Show SummaryChecked
 Show Randomization List.....Checked
 Show Randomization List Details.....Unchecked
 Show ReferencesChecked

Storage Tab

Store Randomization ListChecked
 Store Randomization List Data Starting In<Empty>
 Update output column names...Checked

5 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Randomization List Summary

Randomization List Summary				
Randomization Algorithm	Block Randomization			
User-Entered Random Seed	60502			
Block Size Multiplier(s)	1 2			
Block Size(s)	3 6			
Total Number of Blocks	3			
Overall Total Sample Size	15			
Number of Treatment Groups	3			
	Group		— Allocation % —	
Group	Code	Sample Size	Actual	Target
A	A	5	33.33%	33.33%
B	B	5	33.33%	33.33%
C	C	5	33.33%	33.33%

This report displays the summary of the randomization list, including block information.

Randomization Lists

Randomization List

Randomization List

Randomization Algorithm Block Randomization (Block Sizes = 3 6)
 User-Entered Random Seed 60502

Sequence	Block	Group
1	1	A
2	1	A
3	1	C
4	1	C
5	1	B
6	1	B
7	2	C
8	2	A
9	2	C
10	2	B
11	2	A
12	2	B
13	3	A
14	3	C
15	3	B

The report lists the group to which each item (denoted by Sequence) should be assigned.

Stored Randomization List Data

Row	Row 1	Sample 1	Sequence	Block	Group
1	71	53300	1	1	A
2	20	101800	2	1	A
3	82	122500	3	1	C
4	138	133400	4	1	C
5	64	141400	5	1	B
6	45	151200	6	1	B
7	81	164000	7	2	C
8	119	195400	8	2	A
9	83	202300	9	2	C
10	32	208900	10	2	B
11	74	220600	11	2	A
12	140	233200	12	2	B
13	129	318500	13	3	A
14	105	341000	14	3	C
15	40	357700	15	3	B

In columns 21 and 22 of the Data Table on the Data Window, you'll find the random sample data stored in collapsed format from the Simple Random Sampling procedure. In columns 23 through 25 you'll find the stored list from the Randomization Lists procedure, including the assigned group for each selected value.

Example 6 – Assigning Randomly Selected Values to Groups after Stratified Random Sampling

Suppose you want to randomly select 20% of values from the Resale dataset and assign them to groups within strata with sequential balance. This can be accomplished by first using the Stratified Random Sampling procedure to select the values within each stratum and then using the Block Randomization method in the Randomization Lists procedure to assign the groups.

If you want to randomly assign the selected values to G groups within strata without regard for sequential balance over time, you can accomplish this all in one step using the Simple Random Sampling with Group Assignment procedure.

The purpose of this example is to demonstrate how the Randomization Lists procedure may be used in conjunction with the Stratified Random Sampling procedure to assign actual sampled items to groups. The Randomization Lists procedure contains additional randomization algorithms for assigning items to groups that are not available in the Simple Random Sampling with Group Assignment procedure and may be of interest to the user.

For reproducibility, we will use a random seed of 22077 in the Stratified Random Sampling procedure and a random seed of 60502 in the Randomization Lists procedure.

Part 1: Stratified Random Sampling

Setup

This part of the example will demonstrate how to take a simple random sample from a column in a dataset. We'll select 10% of the values in the column called Price. The sample selection data will be stored in collapsed format in the Data Table with row numbers also stored for reference to the original dataset. The resulting sample data will be sorted by value.

To run this part of the example, complete the following steps:

1 Open the Resale example dataset

- From the File menu of the NCSS Data window, select **Open Example Data**.
- Select **Resale** and click **OK**.

2 Specify the Stratified Random Sampling procedure options

- Find and open the **Stratified Random Sampling** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 2** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Random Sampling Tab	
Sample Size Entry Type	Enter the Percent of Rows/Values to Select
Percent of Rows/Values to Select	20
Dataset Sampling Type	Randomly Select Values from a Column
Column to Sample	Price
Random Seed.....	22077 (for reproducibility)
Stratification Column(s)	State
Sample Allocation among Strata	Equal

Randomization Lists

Reports Tab

Sort Random Sample List(s) **Checked**
 Sort Type **By Selected Row/Value**

Storage Tab

Store the Random Sample(s) in the Data Table **Checked**
 Selection Data to Store..... **Selected Rows/Values (Collapsed)**
 Store the stratification values **Checked**
 Store the original row number of each selected **Checked**
 value

3 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Random Sampling Summary Report

Stratified Random Sampling Summary	
Number of Values Selected	30 of 150 (20%)
Dataset Sampling Type	Values Randomly Selected from Price
Number of Random Sample Replicates	1
User-Entered Random Seed*	22077
Stratification Column	State
Number of Strata	2
Sample Allocation among Strata	Equal
Number of Values Selected by Stratum	State="Nev": 15 of 88 (17.045%) State="Vir": 15 of 62 (24.194%)
Storage: The random sample selection data was stored in columns 21 through 23 of the Data Table.	
* You can use this random seed to replicate this random sample, but the original dataset, number of random samples to generate, and sampling options must be the same.	

This report gives a summary of the random sample that was generated by selecting values from Price. A sample size of 30 corresponds to 20% of all 150 available rows with data. The random sample itself was stored in the Data Table in columns 21 through 23.

Random Sample List Report

Stratified Random Sample 1 of 1			
Number of Values Selected	30 of 150 (20%)		
Dataset Sampling Type	Values Randomly Selected from Price		
User-Entered Random Seed	22077		
Stratification Column	State		
Selected Item	Value from Stratification Column State	Original Row	Value Selected from Price
1	Nev	79	26300
2	Nev	71	53300
3	Nev	57	102200
4	Nev	138	133400
5	Nev	6	147500
6	Nev	123	150100
7	Nev	49	167000
8	Nev	84	183300
9	Nev	108	198000
10	Nev	140	233200
.	.	.	.
.	.	.	.
.	.	.	.

Randomization Lists

21	Vir	47	165900
22	Vir	119	195400
23	Vir	32	208900
24	Vir	74	220600
25	Vir	54	241300
26	Vir	122	241800
27	Vir	98	247500
28	Vir	86	291700
29	Vir	116	328300
30	Vir	34	335300

This report lists in collapsed format the 30 values from Price (20% of all values) that were selected along with their corresponding strata and original row numbers. The report is sorted by value with each stratum.

Part 1: Stored Random Sample Data

Row	Strat Col 1 State	Row 1	Sample 1
1	Nev	79	26300
2	Nev	71	53300
3	Nev	57	102200
4	Nev	138	133400
5	Nev	6	147500
6	Nev	123	150100
7	Nev	49	167000
8	Nev	84	183300
9	Nev	108	198000
10	Nev	140	233200
.	.	.	.
.	.	.	.
21	Vir	47	165900
22	Vir	119	195400
23	Vir	32	208900
24	Vir	74	220600
25	Vir	54	241300
26	Vir	122	241800
27	Vir	98	247500
28	Vir	86	291700
29	Vir	116	328300
30	Vir	34	335300

In columns 21 through 23 of the Data Table on the Data Window, you'll find the random sample data stored in collapsed format. The stored data includes the sampled values ("Sample_1"), the stratification values ("Strat_Col_1_State"), and the original row numbers ("Row_1") of the values selected from Price.

The newly created Note for column "Sample_1" contains the following information about the sampled data.

Stratified Random Sample Storage Column 1 of 1

Number of Values Selected: 30 of 150 (20%)
 Dataset Sampling Type: Values Randomly Selected from Price
 User-Entered Random Seed*: 22077

Stratification Column: State
 Number of Strata: 2
 Sample Allocation among Strata: Equal
 Number of Values Selected by Stratum: State="Nev": 15 of 88 (17.045%); State="Vir": 15 of 62 (24.194%)

* You can use this random seed to replicate this random sample, but the original dataset, number of random samples to generate, and sampling options must be the same.

Part 2: Randomization Lists Procedure

Setup

To run this part of the example, complete the following steps:

4 Specify the Randomization Lists procedure options

- Find and open the **Randomization Lists** procedure using the menus or the Procedure Navigator.
- The settings for this example are listed below and are stored in the **Example 6** settings template. To load this template, click **Open Example Template** in the Help Center or File menu.

<u>Option</u>	<u>Value</u>
Randomization Tab	
Randomization Algorithm	Block Randomization
Random Seed	60502 (for reproducibility)
Block Size Multiplier(s)	1 2
Block-Subject Allocation	Random
Constrain the actual block allocation... ..	Unchecked
Search for a randomization list... ..	Unchecked
Maximum Search Iterations	1000
Sample Size Entry Type	Enter the Overall Total Sample Size for the Study
Overall Total Sample Size	30
Number of Treatment Groups	3
Title or Name	Group
Assign Equal Sample Sizes to All Treatment Groups	Checked
Treatment Group 1 Label	A
Treatment Group 2 Label	B
Treatment Group 3 Label	C
Centers (Strata)Tab	
Number of Centers (Strata)	2
Title or Name	State
Assign Equal Sample Sizes to All Centers (Strata)	Checked
Center (Stratum) 1 Label	Nev
Center (Stratum) 2 Label	Vir
Number of Additional Factors	0
List Options Tab	
Include a Column of Sequence Numbers	Checked
Include a Column of Subject ID's	Unchecked
Include a Column of Block Identifiers	Checked
Include a Column of Combined Stratification Codes	Unchecked
Include a Column of Abbreviated Treatment Codes	Unchecked
Include a Column of Unique Randomization Codes	Unchecked
Reports Tab	
Show Summary	Checked
Show Randomization List	Checked
Show Randomization List Details	Unchecked
Show References	Checked

Randomization Lists

Storage Tab

Store Randomization List **Checked**
 Store Randomization List Data Starting In **<Empty>**
 Update output column names..... **Checked**

5 Run the procedure

- Click the **Run** button to perform the calculations and generate the output.

Randomization List Summary

Randomization List Summary				
Randomization Algorithm	Block Randomization			
User-Entered Random Seed	60502			
Block Size Multiplier(s)	1 2			
Block Size(s)	3 6			
Total Number of Blocks	7			
Overall Total Sample Size	30			
Number of Treatment Groups	3			
Number of Centers (Strata)	2			
Treatments				
Group	Group Code	Sample Size	— Allocation % —	
			Actual	Target
A	A	10	33.33%	33.33%
B	B	10	33.33%	33.33%
C	C	10	33.33%	33.33%
Centers (Strata)				
State	Blocks	Sample Size	— Allocation % —	
			Actual	Target
Nev	3	15	50%	50%
Vir	4	15	50%	50%

This report displays the summary of the randomization list, including strata and block information.

Randomization List

Randomization List			
Randomization Algorithm	Block Randomization (Block Sizes = 3 6)		
User-Entered Random Seed	60502		
Sequence	State	Block	Group
1	Nev	1	A
2	Nev	1	A
3	Nev	1	C
4	Nev	1	C
5	Nev	1	B
6	Nev	1	B
7	Nev	2	C
8	Nev	2	A
.	.	.	.
.	.	.	.
.	.	.	.
23	Vir	6	C
24	Vir	6	A
25	Vir	7	C
26	Vir	7	C
27	Vir	7	A
28	Vir	7	B
29	Vir	7	B
30	Vir	7	A

The report lists the group to which each item (denoted by Sequence) should be assigned.

Randomization Lists

Stored Randomization List Data

Row	Strat	Col 1	State	Row 1	Sample 1	Sequence	Statex	Block	Group
1	Nev			79	26300	1	Nev	1	A
2	Nev			71	53300	2	Nev	1	A
3	Nev			57	102200	3	Nev	1	C
4	Nev			138	133400	4	Nev	1	C
5	Nev			6	147500	5	Nev	1	B
6	Nev			123	150100	6	Nev	1	B
7	Nev			49	167000	7	Nev	2	C
8	Nev			84	183300	8	Nev	2	A
9	Nev			108	198000	9	Nev	2	C
10	Nev			140	233200	10	Nev	2	B
.
.
21	Vir			47	165900	21	Vir	5	B
22	Vir			119	195400	22	Vir	6	B
23	Vir			32	208900	23	Vir	6	C
24	Vir			74	220600	24	Vir	6	A
25	Vir			54	241300	25	Vir	7	C
26	Vir			122	241800	26	Vir	7	C
27	Vir			98	247500	27	Vir	7	A
28	Vir			86	291700	28	Vir	7	B
29	Vir			116	328300	29	Vir	7	B
30	Vir			34	335300	30	Vir	7	A

In columns 21 through 23 of the Data Table on the Data Window, you'll find the random sample data stored in collapsed format from the Stratified Random Sampling procedure. In columns 24 through 27 you'll find the stored list from the Randomization Lists procedure, including the assigned group for each selected value, randomized independently within each stratum.